CLAIMS

We claim:

1. An equilibration method for very high resolution, three-dimensional imaging of pulmonary compliance, wherein the method comprises delivering a predetermined volume of hyperpolarized noble gas into the conducting airways in each ventilated region of the pulmonary system and collecting local magnetic resonance image data therefrom.

2. The method of claim 1, wherein the noble gas is hyperpolarized helium-3 gas (H^3He).

3. The method of claim 2, further comprising dividing the lung images into as many distinct voxels as imaging resolution permits.

4. The method of claim 3, further comprising calculating local lung volume by dividing average signal intensity in each voxel by tracheal signal intensity.

5. The method of claim 4, further comprising calculating average concentration of H^3He in each voxel by dividing an amount of H^3He in each voxel by volume of the voxel, and calculating amount of H^3He in each the voxel by multiplying concentration of H^3He in the gas space of the voxel by volume of gas space in the voxel.

6. The method of claim 5, further comprising calculating compliance of the voxel by calculating pressure difference between alveolar gas inside the voxel and pleural space outside of the lung, and calculating local compliance in the voxel by dividing the volume of the voxel by transmural pressure gradient (tracheal minus esophageal pressures).

7. An equilibration method for very high resolution, three-dimensional imaging of distribution of functional residual capacity (FRC) in the lung using hyperpolarized noble gas, wherein the method comprises delivering a predetermined volume of hyperpolarized noble gas to the conducting airways in each ventilated region of the pulmonary system and collecting local magnetic resonance image data therefrom.

8. The method of claim 7, wherein the noble gas is hyperpolarized helium-3 gas (H^3He).

9. The method of claim 8, further comprising dividing the lung images into as many distinct voxels as imaging resolution permits.

10. The method of claim 9, further comprising, calculating local lung volume by dividing average signal intensity in each voxel by tracheal signal intensity.

11. The method of claim 10, further comprising calculating average concentration of H^3He in each voxel by dividing an amount of H^3He in each voxel by volume of the voxel, and

calculating amount of H^3He in each the voxel by multiplying concentration of H^3He in the gas space of the voxel by volume of gas space in the voxel.

12. The method of claim 11, further comprising calculating local FRC by dividing signal intensity in the voxel by tracheal signal intensity, and then multiplying by volume of the voxel.

13. The method of measuring whole lung FRC by summing all local FRC in each voxel acquired in accordance with claim 12.

14. An equilibration method for very high resolution, three-dimensional imaging of pulmonary compliance and distribution of functional residual capacity (FRC) in the lung using hyperpolarized noble gas, wherein the method comprises delivering a predetermined volume of hyperpolarized noble gas to the conducting airways in each ventilated region of the pulmonary system and collecting local magnetic resonance image data therefrom.

15. The method of claim 14, wherein the noble gas is hyperpolarized helium-3 gas (H^3He).

16. The method of claim 15, further comprising dividing the lung images into as many distinct voxels as imaging resolution permits.

17. The method of claim 16, further comprising calculating local lung volume by dividing average signal intensity in each voxel by tracheal signal intensity.

18. The method of claim 17, further comprising calculating average concentration of H^3He in each voxel by dividing an amount of H^3He in each voxel by volume of the voxel, and calculating amount of H^3He in each the voxel by multiplying concentration of H^3He in the gas space of the voxel by volume of gas space in the voxel.

19. The method of claim 18, further comprising calculating local FRC by dividing signal intensity in the voxel by tracheal signal intensity, and then multiplying by volume of the voxel.

20. The method of claim 19, further comprising calculating compliance of the voxel by calculating pressure difference between alveolar gas inside the voxel and pleural space outside of the lung, and calculating local compliance in the voxel by dividing the volume of the voxel by transmural pressure gradient (tracheal minus esophageal pressures).

21. The method of claim 15, wherein the method for very high resolution, three-dimensional imaging of pulmonary compliance and distribution of functional residual capacity (FRC) in the lung using H^3He is applied to the pulmonary system of a mammalian subject.

22. The method of claim 21, wherein the mammalian subject is human.

23. The method of claim 21, wherein the lung is normal.

24. The method of claim 21, wherein the lung is injured or diseased.

25. The very high resolution, three-dimensional images of pulmonary compliance, produced by the method of claim 15 using hyperpolarized H^3He gas.

26. The very high resolution, three-dimensional images of distribution of functional residual capacity (FRC) in the lung, produced by the method of claim 7 using hyperpolarized H^3He gas.

27. The very high resolution, three-dimensional images of pulmonary compliance and distribution of functional residual capacity (FRC) in the lung produced by the method of claim 14 using hyperpolarized H^3He gas.

28. The system for producing the very high resolution, three-dimensional images of pulmonary compliance and distribution of functional residual capacity (FRC) in the lung in accordance with claim 27, comprising:

means for collecting and processing magnetic resonance imaging data from the hyperpolarized H^3He gas-infused lung, conducting airways and ventilated regions of the lung;

means for dividing the lung images into as many distinct voxels as imaging resolution permits;

means for calculating local lung volume;

means for calculating average amount and concentration of H^3He in each voxel; and

means for calculating local FRC and means for calculating compliance of the voxel and local compliance in the voxel.